

Nonlocal Conservation Laws Derived from an Explicit Equivalence Principle

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Abstract

According to this principle (EEP), in order that the local physical laws cannot change, after changes of velocity and potentials of a measuring system, the relativistic changes of every particle and stationary radiation (that can be used to measure them) must occur in identical proportion, at the same time. In less words, particles and stationary radiations must have the same physical properties. Thus in principle better defined relativistic laws for particles and their gravitational (G) fields can be derived from properties of radiation in stationary state after using nonlocal reference frames that don't change in the same way as the objects. Effectively, the new laws agree with relativistic quantum mechanics and with all of the gravitational tests. The main difference with ordinary gravity is linearity. *The G field itself has not energy to exchange with the bodies and it is not a secondary source of field.* The EEP also fixes a new cosmic context that has fundamental differences with the conventional one. This one has been presented in a separated work as a cosmic test for the EEP. The detailed theory, that includes the new universe fixed by the EEP, was published in a book.

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1 The Mayor Source of Errors in Current Literature

From the EEP, the relativistic changes occurring to an object can only be detected by nonlocal (NL) observers whose instruments have not changed in the same way and proportions as the objects.

This fact is crucial in gravity (G) because the NL experiments such as G time dilation and G red shift prove, definitively, that *the atoms and clocks of observers located in different G potentials are not strictly the same with respect to each other, respectively*. Then, strictly, *the unit systems of observers located in different G potentials are physically different compared to each other*.

Hence, *most of the current comparisons of quantities measured by observers in different G potentials are inhomogeneous, inexact, without strict physical meanings*¹.

Thus to relate quantities measured by observers located in different G potentials, they must be previously transformed to a common unit system based on a standard (or observer) in some fixed (single) and well-defined G potential. To make a difference with the local quantities, these transformed (relativistic) quantities have been called *nonlocal* ones. For the same reason the NL position or potential of the reference standard has been stated by a subscript. The transformation factors can be easily found either from NL conservation laws or, approximately, from strictly homogeneous interpretations of the results of basic experiments, called *gravitational tests* [1]–[11].

2 Nonlocal Conservation Laws for Radiation

2.1 NL frequency conservation

Assume that a continuous train of light waves (or periodical light signals of a fixed frequency) are emitted at the end B of an optical fiber whose other

¹Such comparisons can be as ambiguous as to compare prices in different countries without previous transformations to some common money! This seems to be the mayor source of ambiguities and errors in the present century. Hence some results of this work may look odd if they are erroneously interpreted in terms of current (inhomogeneous) concepts.

end A is in a higher and constant G potential. From *wave continuity* it is inferred that not a single wave or light signal can disappear during its trip BA . According to this, the theoretical number of them that are crossing the ends A and B , in the same unit of time (like that of the observer's clock at A), must be the same. Then the NL frequency of light traveling between B and A , *with respect to the fixed clock at A* , cannot change. Then it may be concluded that, in general, *the NL frequency of light, with respect to a fixed clock (fixed unit system), is conserved during its trip throughout static conservative fields (NL frequency conservation law for radiation).*

Since this property must also holds for single photons, then it may also be concluded

a) That the G red shift detected by the observer at A , of the light coming from B , cannot possibly be due to a real change occurring during the photon's trip. This one can only be due to the lower NL eigen-frequencies (lower NL energy levels) of atoms at B compared with those of the same kind of atoms at A . Notice that *such differences do exist long before light emission*. This is most evident in G time dilation experiments because the light fly time is negligible compared with the measured times and, furthermore, such fly time is canceled out after using time differences.

b) That wave continuity must be a property of a single quantum. This means that the Huygen's principle can be applied to the *quantum-wavelets* that should also have some sort of wave continuity.

Thus the differences of the time intervals detected between clocks of observers located in different G potentials cannot possibly be due to any wavelength lost during the light trips between them. They can only be due to real differences of the natural frequencies of atoms and clocks located in different G potentials.

Since the photon energy depends only on its NL frequency, then, from NL frequency conservation it is also concluded that *the relativistic energy of a photon, with respect to a fixed clock, remains constant during its free trip throughout conservative fields*. In other words, *a free quantum of radiation cannot exchange energy with static conservative fields*. This may be called *the no energy exchange law between radiation and G fields*.

Of course, this may eventually look odd because observers at rest in different G potentials normally measure different frequencies for the same light beam. However this is due to the fact that their clocks run at different frequencies compared to each other. Thus the comparisons of frequencies

referred to different time units have not well defined physical meanings. On the contrary, such differences can be measured just because *the NL frequency of the original photons have remained unchanged during their trips from the NL light source up to the local observer position.*

2.2 Nonlocal Quantum Vector Conservation

A NL frequency vector oriented in its propagation direction, whose absolute value is its NL frequency, can describe more completely the main NL properties of a photon with respect to the observer. Its multiple h is called *NL quantum vector* because its absolute value is just the quantum NL energy with respect to such observer.

From above, according to wavelet continuity, the NL quantum vector of a free photon traveling in a space of isotropic refraction properties cannot change. This fact may be called *NL quantum vector conservation*².

3 Nonlocal Conservation Laws for Particle Models in G Fields

The simplest (one-dimensional) particle model can be made up of a single quantum in stationary state between two perfect mirrors. So far it is not strictly necessary to know the exact mechanism for the perfect model reflections³.

The two components of the model at rest would be mirror reflections with respect to each other. Each of them has a half of the quantum energy. This may eventually be like a neutrino-antineutrino set. Any material part, like an external wave cavity, can be omitted because, according to the EEP, their proportional changes must be identical to those of the stationary radiation⁴.

²So far nobody knows the ultimate reasons for the photon non-spread (stability). Thus we can either accept it, as a well proved fact, or try to find an explanation. It is reasonable that the NL refraction index of the space is larger in the regions of coherent wavelet interference. In this way the photon's wavelets would be systematically deviated towards the original photon orientation.

³It is reasonable that the same mechanism proposed above for the photon non-spread can account for the critical reflections within particle models.

⁴Three dimensional models with radiation traveling in closed paths can in principle be

Two quantum vectors in opposite directions can represent to the model at rest with respect to the observer, each one with a half of the model energy.

According to wave continuity, the waves of the quantum wave-trains (quantum cycles) confined in it are conserved after perfect internal reflections. Thus, in an isolated model (located in a space of constant average NL refraction index) the sum of the NL quantum vectors of and the sum of their absolute values cannot change.

The same holds for more complex systems made up of many particle models. Thus in general, *both the sum of the NL quantum vectors of an isolated system and the sum of their absolute values, with respect to a fixed clock, cannot change.*

The first sum is the net NL quantum vector of the system. Such vector represents to the net number of quantum waves (cycles) per unit of time traveling in some well defined orientation of the space. This is called the NL quantum vector conservation for isolated systems.

The second sum, that of the absolute values of the quantum vectors, is called the NL mass-energy of the system. Such relation is called the NL mass-energy conservation for isolated systems.

It is simple to verify that the net NL quantum vector of the model is equal to the product of its net NL momentum and the NL speed of light [3]–[11]. Thus the conservation of the NL quantum vector of a system, in a space of constant average NL refraction index, corresponds with the current *momentum conservation of isolated systems*.

It is obvious that these NL conservation law do correspond with the conventional ones but only within local ranges in which the current ambiguities can be neglected.

3.1 Relativistic Quantum Mechanics

According to the EEP it is not necessary to make additional postulates to derive, theoretically, its relativistic quantum mechanical properties. Such properties, like the De Broglie waves, come out, naturally, as a consequence of the plain interference of the wavelets of the model components [4]–[11].

described by the sum of several one-dimensional particle models with different orientations and phases between them.

Effectively, the NL laws for the particle model do show a complete correspondence with both special relativity and quantum mechanics. They make possible to understand the physical phenomena in terms of the more dual properties of the radiations.

3.2 Nonlocal Conservation Laws for Particles in G fields

During a free orbit (or a free fall) of a particle model in a static G field, its average NL frequency with respect to a fixed unit system remains constant because the model is made up of radiation that, according to the no exchange law, cannot exchange energy with the field (NL mass-energy conservation).

Notice that the model NL momentum changes can only be due to NL refraction, i.e., due some gradient of the NL speed of light. In principle such phenomenon don't change the quantum energy (self-consistency test). Thus in one way or another, a G field must have a gradient of its NL refraction index.

The NL mass-energy conservation during a free orbit turns out to be a direct consequence of the nature of the particle model. Because, in order that the radiation can be confined in the model, the constructive interference of the quantum wavelets must occur within the model mirrors. Far away from them, the wavelets must interfere with *random phases*, i.e., destructively. Thus both the net wavelet amplitudes and the relative probabilities for existence of energy far away from the model must be null. Thus, to the contrary of current beliefs, *static G fields cannot give up energy to test bodies just because they don't have energy.*

Due to its high importance, this basic law has been verified from several different ways. For example, such law can also be derived from the current gravitational tests, after using more strictly homogeneous NL relationships [11].

Then it is obvious that the energy that appears during the G work can only come from the energy confined in test body. This means that *the G work is done at the cost of a decrease of the NL rest mass-energy of the test body.* Effectively, after a free fall, it is evident that such energy is given away just during the stop. Thus the NL eigen-frequency of either the model or an atom at rest in its final G potential is smaller with respect to the initial ones. This accounts for both the G red shift and the G time dilation observed from

nonlocal viewpoints⁵.

4 The Nonlocal Gravitational field

The model long range field can only be produced by gradients of the NL perturbation rate of the space resulting from random phase wavelets diverging from it. This one accounts for the gradients of the NL properties of the space, mainly of the NL speed of light and of the NL eigen values of the model stationary waves [4], [5], [11].

The NL field equation fixed by the EEP is obviously linear. Thus the orbits of radiations and particle models turn out to be fixed by plain interference of wavelets traveling in a space of variable NL properties. Thus the model accelerations turn out to come from gradients of the NL refraction index of the space that in turn induce gradients of the NL properties of the model. They fix the *NL angular momentum conservation law for radiation and for particles in G fields*. Effectively, they account for the radar time delays, G refractions (deviations of light by G fields), planet's orbits and their perihelion shifts [4], [5], [11].

The linearity of the G field equation, which is fixed by the EEP, results in non conventional properties both for the black holes and for the universe. For this reason the consistency the new astrophysical context with the observed facts has been presented as a test for the EEP [11]–[12].

According to the EEP, the experiments for detection of G waves, after using round trips of light, must give negative results. Thus such experiments would also be fair tests for the present theory provided that they can discriminate them, effectively, from any other kind of radiation.

5 Conclusions

One of the main advantages of using the EEP as a single base for this theory is that the EP is just one of the most unquestionable principles in physics. Since it is stated in a more explicit form, it leaves no alternatives for making

⁵Such changes cannot be detected, locally, at the final position, because every local atom has changed in identical proportion.

arbitrary assumptions. This way it takes the advantages of the actual knowledge of the dual properties of radiations, mainly their quantized properties. In this way everything turns out to be ultimately fixed by the most elemental properties of the quanta of radiation.

Vice versa, the EEP also makes possible to test the current assumptions normally made in current literature and to explore on the nature of particles and elemental properties of the radiations.

This work proves that it is possible to get more out from the Equivalence Principle, after making it more explicit. Anyway, this work can also be used as a guide for future works in this line or for interpreting the phenomena observed in the universe. Of course, there is a lot of work to do in this direction. This work is just a first and rather small step.

Most of the detailed deductions of this work have been included in a book [11] that was presented in the Eight Marcel Grossmann Meeting (June 1997) so to provide more detailed deductions and verifications for the two contributions presented in it. Such book integrates the presentations and publications on this line, done in the last 24 years [1]–[11]. It includes the new astrophysical and cosmological context fixed by the EEP.

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